In Quest of New Fingerprints of Exposure to VOCs from Consumer Products

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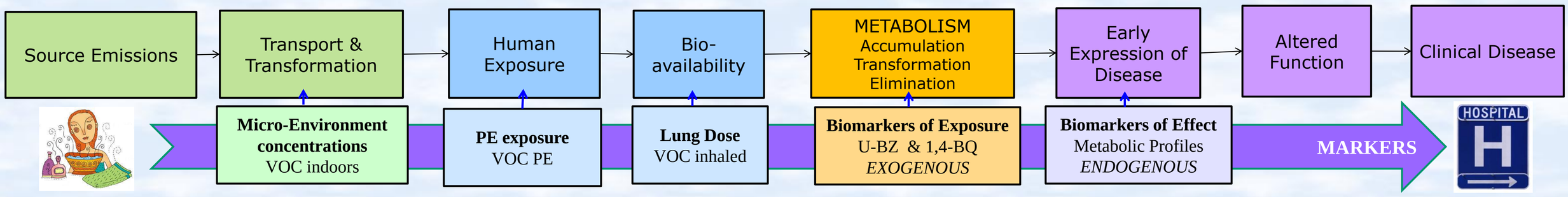
BACKGROUND

Volatile organic compounds **(VOCs) are ubiquitous in indoor** air and their origin includes building related materials, furniture, and consumer products [1]. New buildings or recently redecorated indoor environments have been associated with high concentrations of VOCs. The rate of emission of VOCs from new materials will decay and eventually will reach a quasi steady emission rate indoors [1]. Currently, there is international recognition of the **contribution of indoor air to personal exposures** and its potential health risks associated [2].

Previous work has focused on characterising personal exposures to VOCs [3, 4]. However, estimation of **dose** will provide a more accurate idea of the true lung burden from VOCs. A major goal of environmental epidemiology is **to establish quantitative relationships between exposures to toxic substances and the associated risks of disease**.



Traditional metabolites of benzene are inadequate for biomonitoring benzene at low-level exposures [5]. Recent developments in analytical techniques have opened up the possibility of measuring un-metabolised benzene in urine, as well as benzoquinones as **potential biomarkers of exposure** to VOC. Additionally, omics technologies could be use to assess the biological effect of exposures to VOCs. Since detoxification of benzene involves metabolic transformations, and many metabolites are ultimately excreted in urine [5], using a metabolomics approach can be helpful to identify new metabolite pattern profiles. This profiles could be useful in recognising biological effects in low-level exposure scenarios and serve as **biomarkers of effect**.

HYPOTHESIS AND AIMS

HYPOTHESIS: EXPOSURE-EFFECTS CONTINUUM

- The general population is exposed to different VOC emitted from consumer products and building materials.
- Doses of inhaled VOCs are metabolised producing biomarkers of exposure (exogenous) and effect (endogenous), that can be detected from urine samples

AIMS

To characterize human exposures and to find suitable biomarkers to monitor the exposure and early effects to low-levels of VOCs, especially benzene, arising from consumer and building products.

OBJECTIVES

- Characterise VOC concentrations in indoor microenvironments relevant to personal exposures (home and workplace)
- Characterise personal exposures to a common range of chemicals used in consumer products and building materials
- Model inhalation doses and personal exposures using microenvironment concentrations and subject information
- Characterise biomarkers of exposure to low-level VOC concentrations
- Discover biomarkers of effect using metabolomics

METHODS

SUBJECT RECRUITMENT

GROUP 1 *(N=15)*
Occupationally Exposed

GROUP 2 *(N=15)*
Medium – VOC exposed
New buildings or Redecoration

GROUP 3 *(N=15)*
Control

EXPOSURE ASSESSMENT

Group 1 & 3. Sampled once

Group 2. Sampled twice:

- 1st : when building new
- 2nd : One year later

Concurrent 24- hour personal, home and workplace monitoring

Samples collected in sorbent tubes

Urine collected the day after

Information collected on Activity Diaries

ANALYTICAL METHODOLOGIES

PERSONAL EXPOSURE AND MICROENVIRONMENT ANALYSIS
Thermal Desorption - GC/MS analysis -*Delgado-Saborit et al (2009) Environ Health Persp*

UN-METABOLISED URINARY VOC ANALYSIS
Headspace SPME sampler - GC/MS analysis - *Fustinoni et al (2010) Chem-Biol Interact*

URINARY CREATININE LEVELS
Roche Hitachi P Instrument - Jaffe method

METABOLISED VOC – BENZOQUINONE ANALYSIS
Acetylation to increase sensitivity - GCMS analysis –
Modification of Cho et al (2004) Aerosol Sci Tecnol for airborne samples

METABOLOMICS – ENDOGENOUS METABOLITE PROFILE
NMR analysis - *Viant et al (2007) Metabolomics*
Optimise analysis with G1 (non-targeted)
Target approach for G2 and G3

LUNG DOSE

$$D_L = \frac{\Sigma C_{ME} \cdot t_{ME} \cdot V_E \cdot ABS}{\Sigma t_{ME}}$$

D_L = Lung Dose (µg)
C_{ME} = Concentration measured in each microenvironment (µg/m^3)
Home and Work
Other microenvironments available on
Delgado-Saborit et al (2009) Environ Health Persp

t_{ME} = Time spent in each microenvironment (min)
V_{ME} = Minute ventilation in microenvironment (m^3)
depends on age, gender, level of exertion
values available on
Londahl et al (2007) Inhal Toxicol
ABS = Absorption of chemical

EXPECTED OUTCOMES

- Characterization of **exposures to low levels of VOCs** typically found in consumer and construction products
- Identification of **new VOC biomarkers of exposure** which can be used to biomonitor inhalation doses to VOCs at low level concentrations.
- **New biomarkers of effect** will provide researchers with a valuable tool, which will contribute to understand how environmental exposures from consumer products affect human health.
- This will **help policymakers** in the regulation and industries in the formulation of consumer products preserving the health of the final user (i.e. the general population).

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